

# Westford Antenna

*Michael Poirier*

## Abstract

Technical information is provided about the antenna and VLBI equipment at the Westford site of Haystack Observatory, and about changes to the systems since the 2002 IVS Annual Report.

## 1. Westford Antenna at Haystack Observatory

Since 1981 the Westford antenna has been one of the primary geodetic VLBI sites in the world. Located  $\sim 70$  km northwest of Boston, Massachusetts, the antenna is part of the MIT Haystack Observatory complex.

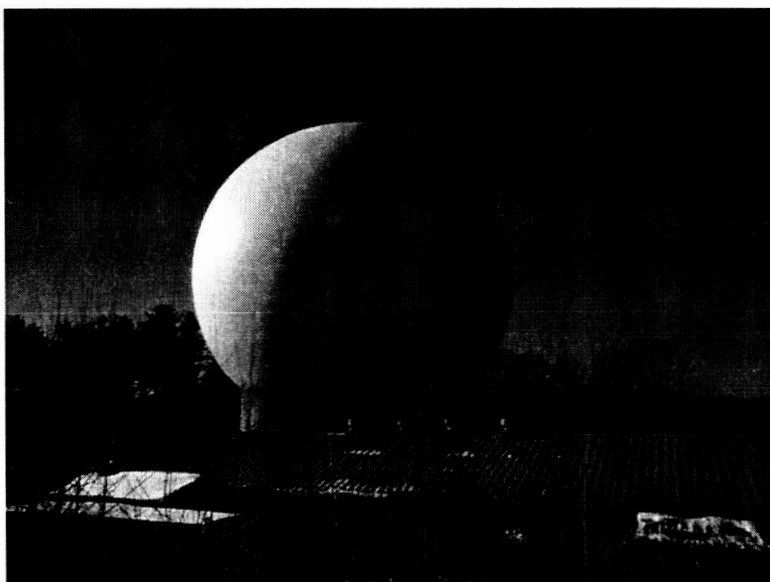


Figure 1. The radome of the Westford antenna.

The Westford antenna was constructed in 1961 as part of the Lincoln Laboratory Project West Ford that demonstrated the feasibility of long-distance communication by bouncing radio signals off a spacecraft-deployed belt of copper dipoles at an altitude of 3600 km. In 1981 the antenna was converted to geodetic use as one of the first two VLBI stations in the National Geodetic Survey Project POLARIS. Westford has continued to perform geodetic VLBI observations on a regular basis since 1981. Westford has also served as a test bed in the development of new equipment and techniques now employed in geodetic VLBI worldwide. Primary funding for geodetic VLBI at Westford is provided by the NASA Space Geodesy Program.

Table 1. Location and addresses of Westford antenna.

Longitude	71.49° W
Latitude	42.61° N
Height above m.s.l.	116 m
MIT Haystack Observatory	
Off Route 40	
Westford, MA 01886-1299 U.S.A.	
<a href="http://www.haystack.mit.edu">http://www.haystack.mit.edu</a>	

## 2. Technical Parameters of the Westford Antenna and Equipment

The technical parameters of the Westford antenna, which is shown in Figure 2, are summarized in Table 2.

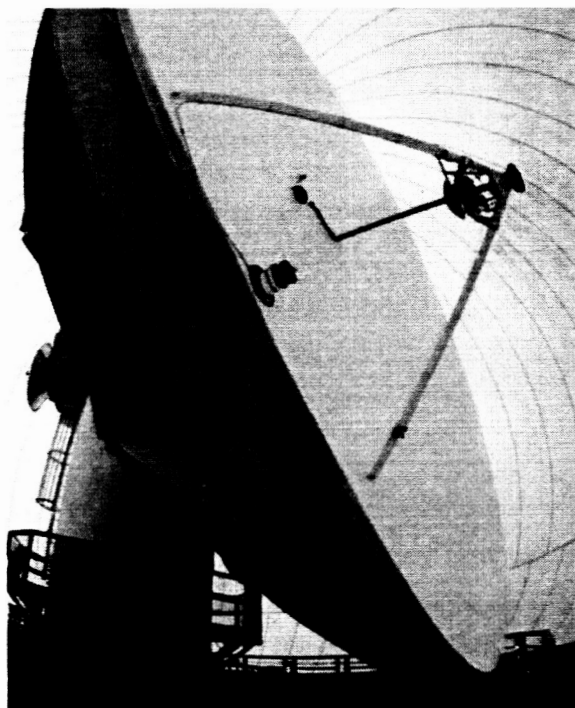


Figure 2. Wide-angle view of Westford antenna inside the radome. The VLBI S/X receiver is located at the prime focus. The subreflector in front of the receiver is installed when observing with the TAL receiver (see Section 4), which is located at the Cassegrain focus.

The antenna is enclosed in a 28-meter-diameter, air-inflated radome made of 1.2-mm-thick, Teflon-coated fiberglass – see Figure 1. When the radome is wet, system temperatures increase by 10–20 K at X-band and by a smaller amount at S-band. The major components of the VLBI data acquisition system are a Mark 4 electronics rack, a Mark 4 tape drive, which is used for recording thin tapes only, a Mark 5A recording system, and a Pentium-class PC running PC Field System

Table 2. Technical parameters of the Westford antenna for geodetic VLBI.

<i>Parameter</i>	<i>Westford</i>	
primary reflector shape	symmetric paraboloid	
primary reflector diameter	18.3 meters	
primary reflector material	aluminum honeycomb	
S/X feed location	primary focus	
focal length	5.5 meters	
antenna mount	elevation over azimuth	
antenna drives	electric (DC) motors	
azimuth range	90° – 470°	
elevation range	4° – 87°	
azimuth slew speed	3° s <sup>-1</sup>	
elevation slew speed	2° s <sup>-1</sup>	
	<i>X-band system</i>	<i>S-band system</i>
frequency range	8180-8980 GHz	2210-2450 GHz
$T_{sys}$ at zenith	50–55 K	70–75 K
aperture efficiency	0.40	0.55
SEFD at zenith	1400 Jy	1400 Jy

version 9.6.9. The primary frequency and time standard is the NR-4 hydrogen maser. A CNS Clock GPS receiver system provides independent timing information and comparisons between GPS and the maser. Westford also hosts the WES2 GPS site of the IGS network. A Dorne-Margolin GPS antenna is located on top of a tower ~60 meters from the VLBI antenna, and a Turbo Rogue receiver acquires the GPS data. A meteorology package provided by the NOAA Forecast Systems Laboratory continually logs meteorological data, which are downloaded daily and are available from the IGS and cignet archives.

### 3. Westford Staff

The personnel associated with the VLBI program at Westford and their primary responsibilities are:

John Ball	pointing system software
Joe Carter	antenna controls
Ellen Cellini	observer
Brian Corey	VLBI technical support
Glenn Millson	observer
Michael Poirier	site manager; chief observer
Alan Whitney	site director

#### 4. Status of the Westford Antenna

During the period 2003 January 1 - 2003 December 31, Westford participated in a total of 71 24-hour geodetic experiments. Westford participated regularly in the IVS-R1, IVS-R&D, and RD-VLBA series of geodetic experiments, as well as four IVS-T2 sessions and various fringe tests and e-VLBI experiments.

A Mark 5A recorder was installed at Westford in June 2003, as a replacement for the Mark 5P prototype used over the preceding year in occasional engineering tests and e-VLBI experiments. The Mark 5A has been used to record all geodetic sessions since June, with the exception of the RD-VLBA experiments, which are still recorded on tape.

There have been no significant equipment failures during this operational period.

Use of the Westford antenna is shared with the Terrestrial Air Link (TAL) Program operated by the MIT Lincoln Laboratory. In this project Westford serves as the receiving end on a 42-km-long terrestrial air link designed to study atmospheric effects on the propagation of wideband communications signals at 20 GHz.

#### 5. e-VLBI Development at Westford

Westford continues to play a key role in the development of e-VLBI. In 2003, a number of e-VLBI demonstration experiments were carried out. Among them was a Kashima (Japan) to Westford UT1 experiment where data were recorded at Kashima and Westford on the K5 system, as well as on the Mark 5A system at Westford. Data were transferred via e-VLBI in both directions, with the necessary format conversion from K5 to Mark 5A format done via software. Correlation was done both on a software correlator in Japan and the Mark 4 correlator at Haystack. Data from the Haystack correlator were transferred to NASA/GSFC for analysis of the UT1 results. All of this was done in less than 22 hours, from data collection to final results!

#### 6. Outlook

We anticipate Westford will be able to participate in the 72 24-hour geodetic experiments that are scheduled for Westford in 2004. More e-VLBI experiments are also planned for 2004.